LIMNODYNASTES FITZINGER (ANURA: LEPTODACTYLIDAE) FROM THE CAINOZOIC OF QUEENSLAND

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Seventy-six frog ilia representing the leptodactylid genus *Limnodynastes* are reported from the Tertiary of Riversleigh Station, Queensland. Four of these are *L.* sp. cf. *tasmaniensis* and the remainder *L. antecessor* sp. nov. Two ilia of *L. ornatus* (Gray) are reported from a Quaternary cave deposit at Riversleigh Station. □*Anura, Leptodactylidae, Limnodynastes, Cainozoic, Queensland.*

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The frog genus *Limnodynastes* Fitzinger is represented by 12 extant species (Frost, 1985). The geographic range of the genus extends throughout Australia but for the Nullarbor Plain and western Eyre Peninsula in South Australia. One species, *L. convexiusculus* (Macleay), reaches southern New Guinea (Zweifel, 1972).

The fossil record of *Limnodynastes* is principally from Quaternary sites, and includes four extant species (Tyler, 1989a). The Tertiary record is restricted to the holotype of *L. archeri* Tyler (1982) from the Etadunna Formation at Lake Palankarinna, north of Lake Eyre, South Australia. The phylogenetic affinities of *L. archeri* clearly lie with *L. ornatus* (Gray) and *L. spenceri* Parker: a pair of species that is so distinctive that recognition of a separate genus for them may be justified (Tyler, Martin and Davies, 1979; Roberts and Maxson, 1986). Given that the latest evidence suggests that *L. archeri* is from the Oligocene (Lindsay, 1987), it is clear that *Limnodynastes* (*sensu lato*) is an old lineage, and the fossil record assumes particular significance.

A large number of frogs has been recovered from Tertiary sites at Riversleigh Station in northwest Queensland. The first species to be reported there was *Lechriodus intergerivus* Tyler (1989b) and, to date, 315 (50%) of the ilia located represent that species. Numerically the second most dominant genus in the samples is *Limnodynastes*. Here I report the Tertiary taxa, and describe one as a new species. In addition I document the finding of *L. ornatus* at a Quaternary site there.

MATERIAL AND METHODS

The specimens reported here were obtained at the Vertebrate Palaeontology Laboratory at the University of New South Wales. They are now deposited in the collections of the Queensland Museum (QM), and the South Australian Museum (SAM). Letters preceding registration numbers are departmental identifications. Unassigned specimens retain the Vertebrate Palaeontology Laboratory reference numbers, which are prefixed AR.

The material consists of isolated and commonly fragmentary ilia. Their safe manipulation has been greatly simplified by the use of a Cosy M200 vacuum pump with an M202 probe which has a terminal compatible with Luer hypodermic syringe needles. The size of the ilia examined was such that 21 to 26 gauge needles were used. To buffer the contact between needle tip and specimen, a short sleeve of silicon rubber tubing was attached to the needle tip. The descriptive format of the material follows Tyler (1976, 1989b).

SYSTEMATICS

Family Leptodactylidae
Limnodynastes Fitzinger

The generic characteristics of the ilium have been defined by Tyler (1976), and exhibit variation according to the species group involved. Hence *L. ornatus* and *L. spenceri* exhibit a dis-

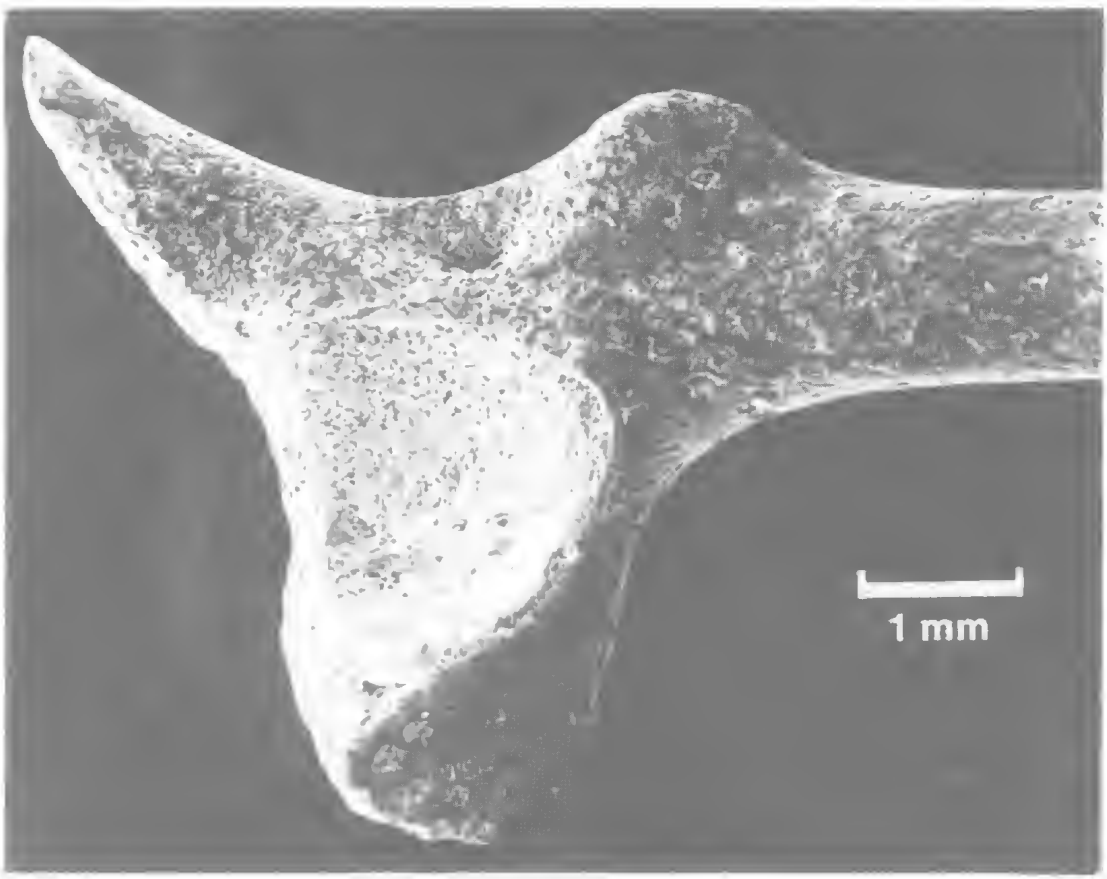

FIG. 1. S.E.M. of QM F17517: distal end of paratype of *Limnodynastes antecessor*.

tinct crest to the ilial shaft, the *L. dorsalis* group a groove upon the medial surface of the shaft, and *L. tasmaniensis* an anteriorly protruding, ventral acetabular expansion. The extension of the dorsal prominence and dorsal protuberance is equally variable. All species share an elongate and tapering dorsal acetabular expansion.

Limnodynastes antecessor sp. nov.
(Fig. 1)

MATERIAL EXAMINED

HOLOTYPE: QM F17510. An almost entire right ilium collected at Gag Site, Riversleigh Station, Queensland.

PARATYPES: There are 18 paratypes: C.S. Site: SAM P29794, P30038, P30042, QM F17518; Gotham Site: SAM P29795; Upper Site: QM F17511-13, 17516-17; SAM P29797, P30050; Gag Site: QM F17514-15; Wayne's Wok Site: QM F17616-18; 17517 subject of S.E.M.).

DESCRIPTION OF HOLOTYPE

Ilial shaft slender, slightly curved, cylindrical and lacks medial groove and dorsal crest.

Acetabular fossa small, deep and with extremely prominent rim anteriorly. Dorsal margin of acetabular fossa situated slightly superior to inferior margin of ilial shaft.

Pre-acetabular zone largely vertical to ilial shaft and inferiorly merges insensibly into moderately developed ventral acetabular expansion.

Dorsal acetabular expansion extremely elongate, tapering to acute point and extending superiorly above ilial shaft.

Dorsal prominence extremely pronounced, rising high above the dorsal margin of ilial shaft. Dorsal prominence situated largely anterior to anterior rim of acetabular fossa, and exhibits

localised, circular depression on level with superior margin of acetabular fossa. Dorsal protuberance poorly developed.

Length of ilium 11.0mm; DAE-VAE 5.9mm; acetabular fossa maximum diameter 2.4mm.

VARIATION

Almost all specimens are incomplete to varying degrees. The largest specimen is SAM P30038. It is complete and has a length of 21.5mm.

The extent of the elevation of the dorsal prominence varies, such that in some paratypes it is not as pronounced as in the holotype. The localised circular depression proximal to the dorsal prominence is variable, and is scarcely detectable in several specimens.

REFERRED SPECIMENS

Portions of an additional 53 ilia are referred to this species but are so incomplete that they do not contribute to an understanding of specific characteristics. For that reason they have been excluded from the type series. Unless indicated specimens have been lodged in the Queensland Museum;

R.S.O. Site: F17591, 17527-8; Upper Site: F17519, 17522-23, 17529, 17595, SAM P30005, P30050, AR14433, F17621-2; C.S. Site: F17520-1, 17592, 17525, 17599, 17587, 17589, 17623, SAM P0006, P30039, P30043, P30046-47, AR11617; Gag Site: F17524, 17600, 17596, 17526, 17594, 17530-2, 17534, 17619, 17625-5; R.T.S.: SAM P30044-45; Wayne's Wok: F17593, 17587, 17620, 17624; Outasite: F17533; Henk's Hollow: F17588, SAM P30048; R.V. Site: F17590; Neville's Garden Site: SAM P30040-41, P30049.

Four of these specimens (SAM P30005-6, AR11617, 14433) are substantially larger than other referred specimens and the type series. Reconstructions indicate that they are derived from individuals with a snout-vent length range of approximately 60- 80mm. Either they represent the maximum size attained by *L. antecessor*, or they represent a distinct species. In the event that the latter suggestion is correct, sub-adult specimens may be indistinguishable from *L. antecessor*. Given the few specimens available I prefer to accept at this stage that they are conspecific; resolution awaits the recovery of complete specimens.

COMPARISON WITH OTHER SPECIES

From *L. ornatus* (Gray) and *L. spenceri* Parker the new species is distinguished by the lack of a dorsal crest upon the ilial shaft. From *L. tasmaniensis* Günther it differs principally in the nature of the pre-acetabular zone and ventral acetabular expansion which protrude conspicuously in that species but not in the new species.

Members of the *L. dumerilii* species group have the superior rim of the acetabular fossa above the level of the inferior margin of the ilial shaft, whereas in *L. antecessor* it lies below it.

Limnodynastes salmini Steindachner has a very small, laterally situated dorsal prominence and protuberance, whereas these features in the new species extend superiorly and thus are more conspicuous.

Limnodynastes convexiusculus is distinguished by possession of a slightly developed dorsal crest to the ilial shaft, absent in *L. antecessor*.

The closest affinity of the new species lies with *L. peroni* (Duméril and Bibron). Both species have the acetabulum situated in a position inferior to the ilial shaft, a well developed acetabular rim, and a lack of longitudinal indentations upon the lateral and medial surfaces of the ilial shaft.

Limnodynastes antecessor is distinguished from *L. peroni* by its less pronounced dorsal prominence, a more acute angle between the dorsal acetabular expansion and the dorsal prominence, and by having a more concave ventral acetabular expansion.

LOCAL DISTRIBUTION AND AGES

Limnodynastes antecessor occurs over a wide range of the Riversleigh Station sites. Archer, Godthelp, Hand and Megirian (1989) indicate that more than 97 sites and corresponding local faunal assemblages have been found there. They have attempted to equate the major of those sites with Sites A-E of Tedford (1967). The *L. antecessor* localities are thought to date from early to late Mioecne.

ETYMOLOGY

The specific name is the Latin for 'ancestor', so alluding here to the ancestral nature of the taxon.

Limnodynastes cf. tasmaniensis Günther

MATERIAL EXAMINED

Four ilia, SAM P30007 R.S.O. Site, SAM P30008 Upper Site, QM F17627-28 C.S. Site, Riversleigh Station, Queensland.

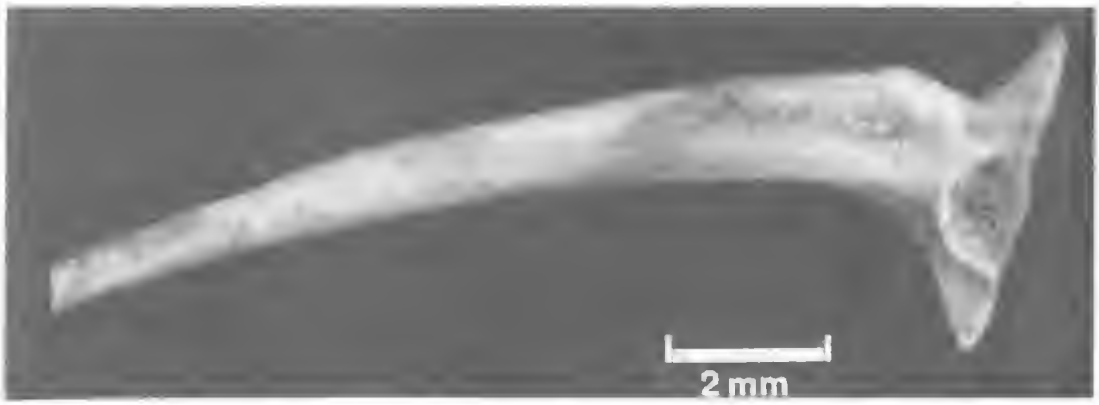

FIG. 2. Photograph of SAM P29798: *Limnodynastes ornatus* from Message Stick Cave, Riversleigh Station.

DESCRIPTIVE NOTES

The specimens form two distinct size groups for whereas SAM P30007 lacks most of the ilial shaft, the length of the proximal portion (4.7mm) equates roughly with a 15mm ilial length, and an approximate body size of 40mm, the remainder are from much smaller individuals. One (SAM P30008) is complete and measures 4.6mm. A second (QM F17627) is 5.0mm and the remaining individuals incomplete but of comparable size. These measurements indicate a body length of 15-20mm. Thus the conspecificity of the material, let alone identity, remains suspect. This is likely to be resolved if more representatives become available.

The association with *L. tasmaniensis* hinges upon the protuberant nature of the sub-acetabular zone so that the margin anterior to the acetabular region is sigmoid (narrowing in the pre-acetabular zone). Contrasting with this evident affinity is the finding that there is a distinct ontogenetic change in the form of the ilial shaft in *L. tasmaniensis*. Metamorphlings and small sub-adults exhibit a dorsal crest characteristic of the *L. ornatus* species group. Such a crest is lost in ontogeny and is lacked by the small fossils. The significance of this feature is being investigated as part of a broader study of ontogenetic trends of skeletal features in the genus in collaboration with M. Davies.

Limnodynastes ornatus (Gray)
(Fig. 2)

MATERIAL EXAMINED

Two ilia, QM F17598, SAM P29798, Message Stick Cave Site, Riversleigh Station, Queensland.

DESCRIPTIVE NOTES

The identification is based upon a combination of two features: firstly the slightly developed dorsal crest of the ilial shaft (shared by *L. ornatus* and *L. spenceri*), and the fact that the ilial shaft is curved; it is straight in *L. spenceri*.

SAM P29798 is a complete ilium, with a total length of 12.7mm, a DAE-VAE distance of 4.2mm, and a fossa diameter of 1.8mm. QM F17598 lacks the distal portion of the ilial shaft and measures 11.0mm: the DAE-VAE distance is 4.1mm, and the fossa diameter is 1.6mm.

COMMENTS

The donor of the larger of the ilial specimens would have had a snout to vent length of approximately 31mm (Fig. 3) which is at the base of the size range of adult males, and less than the range of adult females (Tyler, Smith and Johnstone, 1984).

Message Stick Cave Site is an unreported Quaternary site. The record of *L. ornatus* represents the first fossil record of that species, and the first Quaternary frog to be reported from Queensland.

DISCUSSION

To date 623 anuran ilia have been recovered from the Tertiary sites at Riversleigh Station. Of that total 76 represent *Limnodynastes*, indicating that the genus was numerically a significant component of the fauna.

It is of interest to examine whether the presence of *Limnodynastes* supports the concept of Riversleigh being cool, temperate rainforest in the Tertiary: a conclusion indicated by the predominance of *Lechriodus* there (Tyler, 1989b; Tyler, Hand and Ward, in press.).

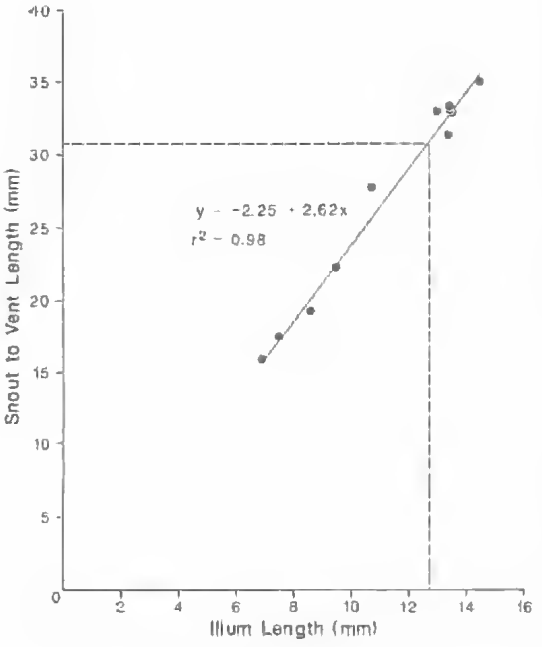

FIG. 3. Regression line of ilium length of *Limnodynastes ornatus* with snout-vent length. Estimated length of largest fossil specimen indicated by broken lines. t-value for slope 21.9735, p. .001. For x = 12.7mm, y = 31.06mm (95% confidence limits = 30.79-31.33).

Modern *Limnodynastes* occupy a diverse range of habitats, and two adaptive modes can be recognised: robust, fossorial forms with shovel-shaped, metatarsal tubercles, or more slender, sharper snouted frogs lacking enlarged metatarsal tubercles (Tyler, Watson and Martin, 1981). There is no absolute association between these modes and the environment. This is because fossorial adaptations occur in species that inhabit extremely demarcated wet-dry climatic regimes (e.g. *L. spenceri*), and also in those that spend shorter periods below the ground in temperate zones (e.g. *L. dumerilii*).

The phylogenetic affinities of the Riversleigh Tertiary *Limnodynastes* species lie with two taxa that are not fossorial. Both of these species extend throughout the East and Southeast of the continent, breeding in static or slow-moving water, but more frequently encountered in open country rather than in rainforest. Thus their presence does not conflict with the assumption of a temperate rainforest but neither does it support that interpretation. *Limnodynastes* species may be too labile in terms of their ecological requirements to be good indicators of palaeoenvironments.

A biological feature shared by *Lechriodus* and *Limnodynastes* is the habit of depositing eggs in foam nests that float upon the surface of water. The process by which the foam nest is produced in the two genera is identical (Tyler and Davies, 1979). Given that this shared biological feature originated in an ancestor to the genera, the origin of the habit is clearly ancient, and which was exhibited by 65% of the individuals at Riversleigh in the Tertiary.

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LITERATURE CITED

ARCHER, M., GODTHELP, H., HAND, S.J. AND MEGIRIAN, D. 1989. Fossil mammals of Riversleigh, northwestern Queensland: preliminary overview of biostratigraphy, correlation and environmental change. *Australian Zoologist* 25(2): 29-65.

FROST, D.R. 1985. 'Amphibian species of the world'.

(Allen Press and Association of Systematics Collections: Lawrence, Kansas).

LINDSAY, J.M. 1987. Age and habitat of a foraminiferal fauna from near-type Etadunna Formation, Lake Palankarinna, Lake Eyre Basin. *South Australian Department of Mines and Energy Report* 87/93, unpublished.

ROBERTS, J.D. AND MAXSON, L.R. 1986. Phylogenetic relationships in the genus *Limnodynastes* (Anura: Myobatrachidae): a molecular perspective. *Australian Journal of Zoology* 34: 561-73.

TEDFORD, R.H. 1967. Fossil mammals from the Carl Creek Limestone, northwestern Queensland. *Bulletin of the Bureau of Mineral Resources, Geology and Geophysics, Australia* 92: 217-36.

TYLER, M.J. 1976. Comparative osteology of the pelvic girdle of Australian frogs and description of a new fossil genus. *Transactions of the Royal Society of South Australia* 100: 3-14.

1982. Tertiary frogs from South Australia. *Alcheringa* 6: 101-3.

1989a. 'Australian frogs'. (Viking O'Neil: Melbourne). 220 pp.

1989b. A new species of *Lechriodus* (Anura: Leptodactylidae) from the Tertiary of Queensland, with a redefinition of the ilial characteristics of the genus. *Transactions of the Royal Society of South Australia* 113: 15-21.

TYLER, M.J. AND DAVIES, M. 1979. Foam nest construction by Australian leptodactylid frogs (Amphibia, Anura, Leptodactylidae). *Journal of Herpetology* 13(4): 509-10.

TYLER, M.J., HAND, S.J. AND WARD, V.J. in press. Analysis of the frequency of *Lechriodus intergerivus* Tyler (Anura: Leptodactylidae) in Oligo-Miocene local faunas of Riversleigh Station, Queensland. *Australian Zoologist* .

TYLER, M.J., MARTIN, A.A. AND DAVIES, M. 1979. Biology and systematics of a new limnodynastine genus (Anura: Leptodactylidae) from northwestern Australia. *Australian Journal of Zoology* 27: 135-50.

TYLER, M.J., SMITH, L.A. AND JOHNSTONE, R.E. 1984. 'Frogs of Western Australia'. (Western Australian Museum: Perth). 108 pp.

TYLER, M.J., WATSON, G.F. AND MARTIN, A.A. 1981. The Amphibia: diversity and distribution. pp. 1277-1301. *In* A. Keast (ed.) 'Ecological biogeography of Australia'. (W. Junk: The Hague).

ZWEIFEL, R.G. 1972. A review of the frog genus *Lechriodus* (Leptodactylidae) of New Guinea and Australia. *American Museum Novitates* 2507: 1-41.